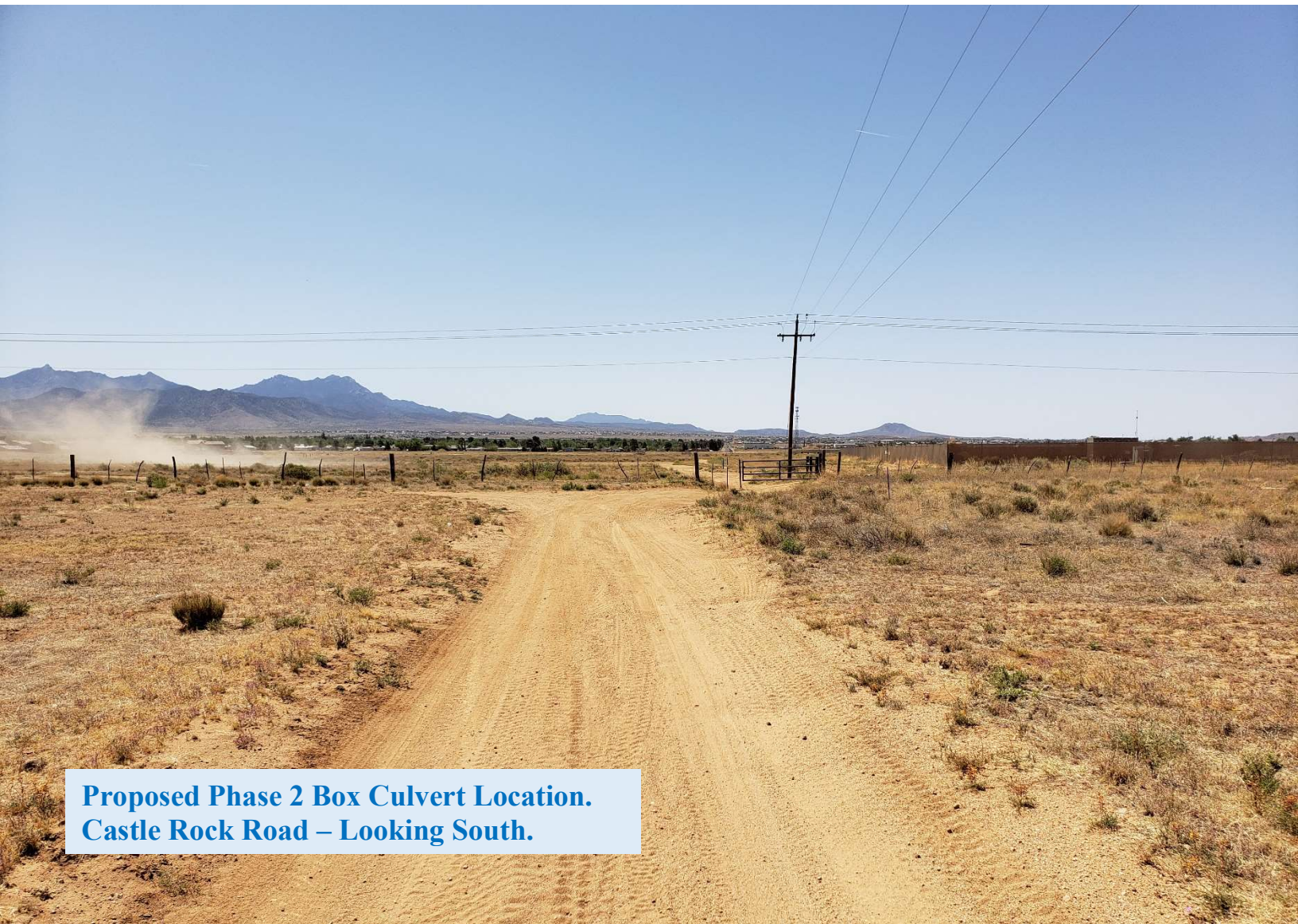
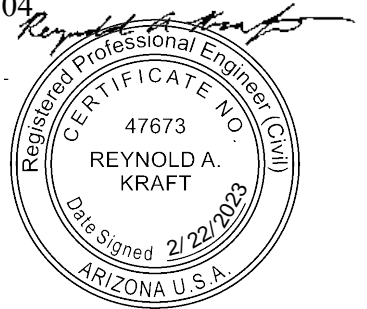


GRACE NEAL CHANNEL – PHASE 2 FINAL DESIGN SPECIAL PROVISIONS

February 2023

Prepared For:
Mohave County Flood Control District
3250 East Kino Avenue
PO Box 7000, Kingman, AZ 86402

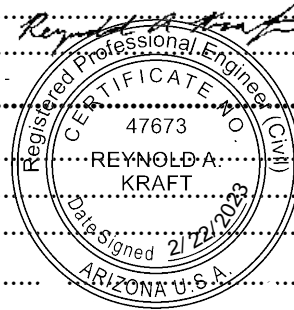
Prepared By:
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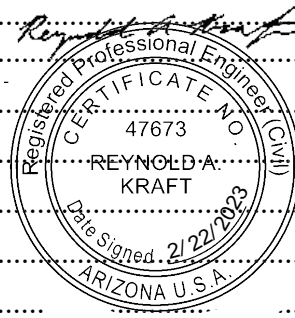
**Proposed Phase 2 Box Culvert Location.
Castle Rock Road – Looking South.**

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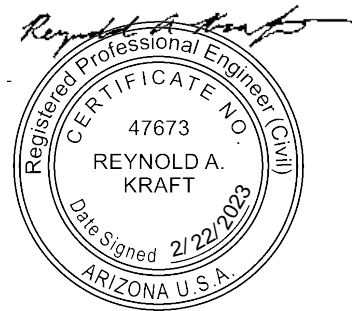
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1 PART 100 – GENERAL CONDITIONS

1.1 Base Specifications

All construction shall be performed according to applicable Mohave County Standards and by reference the Maricopa Association of Governments (MAG) Specifications and Details, 2023 Revisions unless noted otherwise on the drawings or in the Special Provisions.

Any variance to the specifications, originating from the contractor, Mohave County or the City of Kingman, requires the approval of an engineer representing either Mohave County or the City of Kingman. Specifically, variance approvals related to water and sewer facilities will be addressed by the City of Kingman's engineer. All other variance approvals will be addressed by Mohave County's engineer.

1.2 MAG Section 104: Scope of Work

104.1.2 Maintenance of Traffic: is MODIFIED to add the following:

The Contractor shall coordinate with the Mohave County and the City of Kingman to allow for continued access through their facilities throughout the duration of the construction.

Construction outside standard working hours must be approved by Mohave County prior to commencing work.

The Contractor shall submit a Construction Schedule at the Pre-Construction Meeting which addresses potential road closures for coordination.

1.3 MAG Section 105: Control of Work

105.2 Plans and Shop Drawings: is MODIFIED to add the following:

The items of work for which the Contractor is responsible for submitting the required shop drawings shall include, but not be limited to:

- a) Construction Schedule
- b) Concrete Mix Design
- c) 14" DIP Water Line, Metal Detection Tape, Fittings, Adapters
- d) Testing Plan
- e) Switch Over Plans (water)
- f) 36" RCP Connection to RCB (for alternative but equivalent approaches)
- g) Stormwater Pollution and Prevention Plan

105.6 Cooperation with Utilities: is MODIFIED to add the following:

The Contractor is responsible for locating, relocating, and/or protecting all utilities in conflict or within the clear zone, at no expense to the Mohave County or the City of Kingman.

The Contractor is responsible for maintaining and supporting all utilities (not identified for relocation or removal) crossing an open trench. All utilities crossing an open trench shall be protected to the satisfaction of the Mohave County. Any damage to the existing utilities within the construction area shall be repaired by the Contractor to the satisfaction of the Mohave County at no additional cost to the Mohave County.

The following utilities are expected to be located within the limits of this project:

Type	Owner	Contact Number
Water	City of Kingman	928-757-7467
Sanitary Sewer	City of Kingman	928-757-7467
Electric	Unisource Energy Services	928-681-8913

1.4 MAG Section 106: Control of Materials

106.2 Samples and Tests of Materials: is MODIFIED to add the following:

The Contractor shall notify a geotechnical firm, no less than two (2) working days and no more than four (4) working days prior to commencing the construction for which testing is required.

1.5 MAG Section 107: Legal Regulations and Responsibility to Public

A. AZPDES (NPDES) Construction General Permit Requirements: Unless otherwise directed by the Owner, the Contractor shall be responsible for compliance with the Arizona Pollutant Discharge Elimination System (AZPDES) requirements administered by the Arizona Department of Environmental Quality (ADEQ).

B. Regulation Compliance:

1. The Contractor shall take all necessary measures to assure compliance of employees and subcontractors with the AZPDES Construction General Permit for Arizona as well as all other applicable federal, state and local laws, ordinances, statutes, rules and regulations pertaining to storm water discharge and air, ground water and surface water quality. As the permittee, the Contractor is responsible for preparing, in a manner acceptable to the ADEQ and the EPA, all documents required by regulation, which shall include but not necessarily be limited to the following:
 2. Notice of Intent (NOI)
 3. Storm Water Pollution Prevention Plan (SWPPP)
 4. Notice of Termination (NOT)

C. NOI Submittal:

1. Preliminary copies of the NOI and the SWPPP shall be submitted to the County during the preconstruction conference and shall be subject to review by the



- County prior to implementation.
2. The Contractor shall ensure the completed and duly signed NOI form(s) are submitted in a timely manner to prevent a delay to project construction.
 3. The AZPDES form shall be submitted to ADEQ's Phoenix office by certified mail or hand delivered to the address below.
 4. Storm Water Program- Water Permits Section/NOI
 Arizona Department of Environmental Quality
 1110 West Washington Street, 5415B-3
 Phoenix, AZ 85007
 5. The form may also be faxed to ADEQ at 602-771-4674 or submitted via "smart NOI" accessible from the ADEQ's website:
 6. <http://www.ev.state.az.us/enviro/water/permits/stormwater.html>
 7. If the construction is near impaired or unique water, the SWPPP shall be submitted with the NOI Permit activation may require 32 business days or more for construction sites near impaired or unique waters, as well as for construction sites with special concerns, therefore, documentation is to be submitted to ADEQ as early as possible (preferably at least 32 business days prior to the desired start of construction).
 8. All local municipalities within the construction project limits shall be notified, as applicable.
 9. A copy of all submitted NOI forms shall be posted at the construction site. An additional copy shall be submitted to the Construction Manager.

D. Time Extension:

Failure by the Contractor or subcontractor of any tier to submit a NOI within the mandated time frame shall result in delay of the construction start date and no claims for extension of time will be granted for such a delay.

E. SWPPP:

The Contractor shall develop, implement, update and revise the SWPPP, as necessary, to assure compliance with permit requirements. The SWPPP shall be retained on the project site always during construction. Copies of forms and guidance for preparing the SWPPP are available in the "Drainage Design Manual for Maricopa County, Volume III Erosion Control". The manual is available at the Flood Control District, 2801 West Durango Street, Phoenix, Arizona 85009. In addition, a "Construction SWPPP Checklist" can be obtained from ADEQ for assisting in the preparation of the SWPPP.

F. Inspections:

The Contractor shall perform inspections of all storm water pollution control devices on the project once every fourteen (14) days and within twenty-four (24) hours of each 0.5-inch or greater storm event, as required under the provisions of

the AZPDES Construction General Permit for Arizona. The Contractor shall prepare reports on such inspections and shall retain the reports for a period of at least three (3) years following the completion of the project. Inspection reports shall be submitted monthly to the County along with progress payment requests. Additionally, the Contractor shall maintain all storm water pollution control devices on the project in proper working order, which shall include cleaning and/or repair during the duration of the project and until the site follows the AZPDES permit for final stabilization and the NOT is submitted.

G. NOT Submittal:

Upon project completion, acceptance demobilization, and final stabilization, the Contractor shall submit to the permitting agency a completed, duly executed Notice of Termination form for each NOI issued, with a copy to appropriate municipalities, thereby terminating all AZPDES permit coverage for the project. The Contractor shall then provide to the County copies of the SWPPP, inspection information and all other documents prepared and maintained by the Contractor in compliance with the AZPDES Construction General Permit. The Contractor shall retain the originals of such documents for a period of at least three (3) years following the completion of the project and make such documents available for inspection by representatives of the Environmental Protection Agency, the Arizona Department of Environmental Quality, the County, and any municipality having jurisdiction, upon request.

H. Fines and Penalties:

Fines and penalties imposed by the ADEQ or the EPA for Contractor's failure to comply with any or all of the permit requirements shall be borne by the Contractor.

I. Payment:

The lump sum price for AZPDES shall include all material, labor, and costs relating to the NOI, NOT, and the SWPPP. This includes but is not limited to the preparation, installation, maintenance, and removal of temporary SWPPP elements, assuring proper operation of the pollution control devices installed, and all maintenance, cleaning, and disposal costs associated with clean-up and repair following storm events, runoff or releases on the project. The lump sum price for AZPDES shall be inclusive of all related costs, and no additional claims shall be made by the Contractor under any other specification provision, including changed conditions. The Contractor shall be compensated for this item at a rate of 25 percent of the total contract price paid with the first progress payment, the remaining 75 percent will be prorated over the entire length of the project.

2 PART 200 – EARTHWORK

2.1 Section 220: Riprap Construction

Section 220.6: is MODIFIED to add the following:

Where indicated in the construction plans, the Contractor shall grout (or equivalent flowable fill) rock within the gabion baskets sufficient enough to prevent the passage of stormwater through the gabion.

3 PART 500 – STRUCTURES

3.1 Section 505: Concrete Structures

Section 505 is replaced by ADOT Section 601 Concrete Structures, latest edition.

4 PART 600 – WATER, SEWER, STORM DRAIN AND IRRIGATION

4.1 MAG Section 601: Trench Excavation, Backfilling and Compaction

Section 601: Modified as shown below Per City of Kingman Modifications:

SECTION 601.4.3 (revised 2010) *Add New Table:*

Minimum testing requirements for Aggregate backfill for Structure, trench backfill, pipe bedding and shade:

Proctor – sample point at stockpile – one per source

P.I. – sample point at stockpile – one per source

Gradation – sample point at stockpile – 1 per 500cy per source.

*Additional tests may be required as deemed necessary by the City of Kingman Engineering Representative.

SECTION 601.4.4 (revised 2010) *Add New Table:*

Minimum frequency for compaction testing of trench backfill includes water / sewer mains, service lines, telephone, gas, electric, cable tv or other utilities or appurtenance.

Parallel to street centerline: Minimum of one per lift per 500ft

Perpendicular to street centerline: Minimum one per lift per crossing.

*Additional tests may be required as deemed necessary by the City of Kingman Engineering Representative.

SECTION 601.4.5 (revised 2012) *Delete: use of water consolidation as a means of achieving Compaction.*

"Mechanical compaction in accordance with this section shall be performed to achieve desired compaction in all locations where Backfill Type I, II or III is required per Table 601.2.

4.2 MAG Section 610: Water Line Construction

Section 610: Modified as shown below Per City of Kingman Modifications:

SECTION 610.3 (revised 2010) *Add text concerning unacceptable ultraviolet exposure:*

Polyvinyl chloride pressure pipe showing signs of physical damage or unacceptable ultraviolet exposure, as determined through visual inspection by the City of Kingman Engineering Representative, may be rejected. Pipe stored outside, and exposed to sunlight for more than thirty (30) days, shall be covered

with an opaque material such as canvas. Clear plastic sheets shall not be used for pipe cover. Air circulation shall be provided under the covering.

SECTION 610.3.1 (added 2012)

Water line materials containing Brass or Bronze must comply with the current NSF 61 Standards at the time the project begins.

SECTION 610.4 (revised 2012) *Add to last paragraph:*

Any vertical deflection of 22 ½ degrees or more will require ductile iron with approved joint restraints per Mag Standard Details 302-1, 302-2, 303-1 and 303-2 unless specified otherwise in the special provisions, plans or by the City Engineer.

Repair Sleeves/Couplers or any line coupling or splice fitting shall not be used unless approved otherwise the City Engineer.

Pipe bevels shall be removed when required at fittings, valves, fire hydrants and related

appurtenances and the pipe marked so proper depth of pipe insertion can be verified.

SECTION 610.5.5 (revised 2012) delete both notes in paragraph allowing concrete encasement,

And add to end of paragraph:

Concrete encasement as a means of extra protection will not be allowed unless approved otherwise by the city engineer.

SECTION 610.10 (revised 2017) add to wording for water shutdown of an existing water main.

Shut down date & times shall be authorized by the city of Kingman. Typical times are from 9am to 3pm M-F. Notification of water service customers shall be a minimum of 24 hours prior to shut down. The contractor shall distribute shutoff notices to each individual water service customer affected at no additional cost to the city.

SECTION 610.11 (revised 2017)

When plans call for connections from a new water main to an existing water meter, the work shall include schedule 80 PVC pipe for services up to 2" per City of Kingman Standard Detail 344-1. Restrained ductile iron pipe will be used for 3-inch and larger service lines. meters and boxes shall be set parallel to the street centerline and to the finish grades and locations specified in the special provisions, plans or at the direction of the City of Kingman Engineering Representative.

When plans call for the abandonment of water services the old meter shall be removed and the angle meter stop plugged with an approved threaded plug.

SECTION 610.12 (revised 2010) *Fire Service Line Connections – Add wording:*

It is the contractor's responsibility to coordinate onsite construction requirements, testing and inspections with the Fire Department that has jurisdictional authority over the project.

SECTION 610.15 (revised 2017) *Modify wording for pressure test:*

All new lines and fittings shall be pressure tested against new valves unless approved otherwise by the City Engineer.

Acceptance pressure and leakage testing of new water mains shall be made AFTER subgrade preparation is completed and all utilities have been installed within the right-of-way.

Contractor shall provide gauges used for pressure testing. Gauges shall be used with a range based on test pressure putting the indication approximately mid-span. Any gauges deemed defective or inaccurate by the City of Kingman Engineering Representative shall be replaced by an acceptable gauge at the contractor's expense.

Hydrostatic pressure and leakage testing for all water mains and appurtenances including Ductile Iron Pipe shall be per applicable portions of M.A.G. Spec. 610.15 or as modified herein and shall be performed concurrently for a minimum of 2 hours or as directed by the City of Kingman Engineering Representative. Allowable leakage for will be in U.S. Gallons per hour. Pressure and Leak testing of PE piping systems shall be per ASTM F2164-13.

ND \sqrt{P}

Formula: $L = \frac{ND\sqrt{P}}{7400}$

7400

Where:

L = Testing allowance (makeup water) in gallons per hour

N = Number of joints being tested

D = Nominal diameter of pipe in inches

P = Average observed test pressure of the pipe measured at the lowest end of test section shall be a minimum of 200 psi for lines smaller than 16 inches and 150 for lines 16 inches or larger unless specified otherwise in the special provisions, plans or by the City of Kingman Engineering Representative.

4.3 **MAG Section 611: Water, Sewer, and Storm Drain Testing**

Water Line Testing shall be performed in accordance with the following MAG Standard Specification Sections, as shown on the plans and the following City of Kingman amendments and supplements thereto:

SECTION 611.7 (revised 2017) – *Modify section to specify disinfection process:*

A mixture of Sodium Hypochlorite and water shall be used for the disinfection of water mains and associated appurtenances per ADEQ Engineering Bulletin No. 8. Any other disinfection method must be approved by the City of Kingman Engineering Representative. Brass service saddles and corp stops per 344-1 shall be provided by the contractor at locations directed by the city engineer for the introduction of the disinfection solution and testing.

SECTION 611.8 (revised 2010) – *Modify existing section concerning introduction of chlorine into water systems:*

The mixture of water and sodium hypochlorite shall only be introduced into the water main, fire hydrants, fire service lines or associated appurtenances by a method and concentration that is approved by the City of Kingman Engineering Representative.

SECTION 611.10 (revised 2017) – *Rewrite paragraph to reflect chlorination process:*

The initial chlorine content shall be measured and authorized for use by a City of Kingman Engineering representative before introduction into the line. The Minimum residual chlorine content after 24 hours shall be no less than 10ppm. Maximum chlorine concentration shall not exceed 150ppm in any part of the line. Chlorinating agent retention period shall not exceed 72 hours.

SECTION 611.15 (revised 2010) *Revise 3rd paragraph to specify Bac-T sample frequency:*

Sample frequency shall be one per 1000ft with one minimum or as determined by the City of Kingman Engineering Representative.

4.4 **MAG Section 615: Sanitary Sewer Line Construction**

Section 615: Modified as shown below Per City of Kingman Modifications:

SECTION 615.6 (revised 2004) *Sanitary Sewer Service Taps:*

SECTION 615.6.1 (revised 2004) *Add Repair/Replacement of Existing Sewer Service Lines:*

A plumber or contractor wishing to make a repair or replacement of an existing sewer service line must first obtain a City Right-of-Way permit and Sewer Tap permit (if applicable) and pay all appropriate fees. 48 hours advance notification to the Public Works Inspection Department is required prior to actual construction.

The contractor must then expose the existing service line to the sewer main to determine the condition of the existing line and tap. If the existing tap is usable per current City and UPC standards. The contractor has the option of utilizing the existing tap or installing a new service tap, which will require a Sewer tap permit. If a new tap is made, the old tap must then be capped or plugged at the sewer main by an acceptable method such as a VCP cap, plug and epoxy, grout, or concrete encasement.

SECTION 615.10 (revised 2004) *Testing:*

Acceptance testing of new sewer lines shall be made AFTER subgrade preparation is completed and all utilities have been installed within the right-of-way.

SECTION 615.11 (A) (6) (revised 2010) *Add pressure gauge specification to note 6:*

Contractor shall provide gauges used for pressure testing. Gauges shall be used with a range based on test pressure putting the indication approximately mid-span. Any gauges deemed defective or inaccurate by the City of Kingman Engineering Representative shall be replaced by an acceptable gauge at the contractor's expense.

SECTION 615.11 (A) (7) (revised 2010) *Replace note 7 with low pressure air specification:*

Low Pressure Air Acceptance testing will be per ASTM F-1417-92, (2005) or latest revision.

SECTION 615.11 (D) (revised 2010) *Revise paragraph specifying closed circuit camera*

inspection of sewer:

All new sewer mains shall have the interior visually inspected prior to paving using a remote closed circuit camera. The city will provide closed circuit camera service with the contractor's cooperation. The contractor shall coordinate with the City of Kingman Waste Water Superintendent to schedule closed circuit camera inspections. The contractor shall make manholes and cleanouts accessible and safe for the cities waste water crew and run water through the main prior to the interior inspection to the extent deemed necessary by the City of Kingman Waste Water Superintendent. If the contractor fails to schedule or cooperate with the city and or paving is already completed, the contractor will provide closed circuit camera inspection with DVD or VHS documentation at no cost to the city. Any defect in the pipe or construction methods revealed by the closed circuit camera inspection that's deemed unacceptable to the waste water superintendent shall be corrected by the contractor at no additional cost to the City of Kingman. This includes but not limited to bellies in the main indicated by standing water, dirt & debris, lips at joints, shifted connections at couplers or unacceptable service line connections at the main.

SECTION 615.11 (E) (revised 2010) *Add lamp lighting or remote camera testing requirement.*

All sewer line shall be tested for uniform slope by lamp lighting or remote camera per Arizona Administrative Code R18-9-E301.4.01. In the event remote camera services are not available, the engineer of record or his designee will conduct the lamp lighting test at no cost to the city.

5 PART 700 – MATERIALS

5.1 MAG Section 725 Portland Cement Concrete

MAG Section 725 – Portland Cement Concrete is replaced by ADOT Section 1006 Portland Cement Concrete: Included in its entirety by reference.

5.2 MAG Section 796 Geosynthetics

High survivability filter fabric shall meet the requirements for Class B Erosion Control Geosynthetics per section 796.2.3 and/or ADOT Section 1014-4.03.

ADOT Section 1014-1 General Requirements: Included in its entirety by reference.

5.3 Reinforcing Steel

ADOT Section 1003 Reinforcing Steel: Included in its entirety by reference.

6 PART 900 – INCIDENTALS

6.1 Wire Fence

ADOT Section 903 Wire Fence: Included in its entirety by reference.

6.2 Bank Protection

ADOT Section 913 Bank Protection: Included in its entirety by reference.

Channel lining shall be constructed, installed, and filled in accordance with ADOT Section 913 and manufacturers specifications and instructions.

6.3 Walls and Miscellaneous Structures

ADOT Section 914 Walls and Miscellaneous Structures: Included in its entirety by reference.

7 FLEXAMAT[®] CONCRETE BLOCK SYSTEM

7.1 Description

Tied Concrete Block Mats (TCBM)

This work shall consist of furnishing and placing the TCBM system in accordance with this specification and conforming with the lines, grades, design, and dimensions shown on the plans.

7.2 Materials

TCBMs are manufactured from individual concrete blocks tied together with high strength UV resistant polypropylene bi-axial geogrid. Each block is tapered, beveled and interlocked and includes connections that prevent lateral displacement of the blocks within the mats when they are lifted for placement.

Tied Concrete Block Mats shall be Flexamat UV-T-10NW, manufactured by Motz Enterprises, Inc. or approved equal.

7.2.1 Blocks

Furnish blocks manufactured with concrete conforming to the cement requirements of ASTM C150 and to the aggregate requirements of ASTM C33. Meet a minimum compressive strength of 5,000 psi at 28 days. Furnish blocks that have a minimum weight of 3 lbs. per block and placed no further than 2 in. apart. Material shall have a weight per square foot not exceeding 10 lbs. Blocks shall have a 2.25" profile, a flat-top pyramid shape, and a coarse finish without protrusions.

7.2.2 Polypropylene Bi-Axial Geogrid

The interlocking geogrid shall be composed of polypropylene multifilament yarns coated with high ultra-violet resistant based coating with a tan color, which is designed to resist degradation in environments with exposure to ultra-violet light, water and low pH (4 pH) and high pH (>9 pH). When combined with the revetment mat, this will yield a high tenacity, low elongating, and continuous filament polypropylene fibers that is securely cast into and embedded within the base of the concrete blocks and obtains connection strength greater than that of the geogrid. Ensure the geogrid meets the following requirements:

Polypropylene Bi-Axial Geogrid Requirements

Property	Unit	Test	Requirement
Mass/Unit Area	oz/yd ²	ASTM D5261	6.5 oz/yd ²
Aperture Size	English units	Measured	1.4x 1.4 inch
Ultimate Wide Width Tensile Strength (MD x CMD)	lb/ft	ASTM D6637	2,055 lb/ft
Elongation at Ultimate Tensile Strength (MD x CMD)	%	ASTM D6637	≤ 8%

Property	Unit	Test	Requirement
Wide Width Tensile Strength @ 2% (MD x CMD)	lb/ft	ASTM D6637	822 lb/ft
Wide Width Tensile Strength @ 5% (MD x CMD)	lb/ft	ASTM D6637	1,640 lb/ft
Tensile Modulus @ 2% (MD x CMD)	lb/ft	ASTM D6637	41,100 lb/ft
Tensile Modulus @ 5% (MD x CMD)	lb/ft	ASTM D6637	32,800 lb/ft
UV Resistance (4000hr)	% retained/hr	ASTM G154	100% Retained Strength
Color	Color Chart	Visual	Tan

7.2.3 Underlayment material

Mats shall be installed over a 10oz non-woven geotextile consisting of the following properties:

7.2.4 Any geotextile seams shall be overlapped 24"

7.2.5 TCBM shall be continuous sections running from the levee crest to toe without seams within TCBM system.

7.2.6 Each TCBM section shall have an overlapping extension on one long edge. Overlapping extensions shall consist of an 8" extension of the interlocking bi-axial geogrid.

7.2.7 Cover the TCBM or otherwise protect it during long periods of storage to protect against degradation of the backing material as recommended by the manufacturer.

7.2.8 TCBM will be rolled for shipment and are packaged with handling straps.

All mats to be inspected upon delivery. Assure that all units are sound and free of defects that would interfere with the proper placing of the unit or impair the strength or permanence of the construction.

Chipping or missing concrete resulting in a weight loss exceeding 15% of the average weight of a concrete unit is grounds for rejection by the engineer. Replace, repair or patch the damaged areas per the manufacturer's recommendations.

7.3 Performance

Full-Scale laboratory testing performed by an independent 3rd party testing facility with associated engineered calculations certifying the hydraulic capacity of the proposed Tied Concrete Block Mat meets the following requirements:

Test	Tested Value	Bed Slope	Soil Classification	Limiting Value
ASTM 6460	Shear Stress	30%	Sandy Loam (USDA)	24lb./ft ²
ASTM 6460	Velocity	20%	Loam (USDA)	30 ft./sec

7.4 Equipment

Provide the proper equipment to place the mat that will not damage the mat material or disturb the topsoil subgrade and seed bed.

7.5 Construction

Prior to installing TCBM, prepare the subgrade as detailed in the plans. All subgrade surfaces to be smooth and free of all rocks, stones, sticks, roots, and other protrusions or debris of any kind that would result in an individual block being raised more than 3/4 in. above the adjoining blocks. When seeding is shown on the plans, provide subgrade material that can sustain growth.

Ensure the prepared subgrade provides a smooth, firm, and unyielding foundation for the mats.

When vegetation is required, distribute site specific seed on the prepared topsoil subgrade before installation of the concrete mats in accordance with the specifications.

Install mats to the line and grade shown on the plans and per the manufacturer's guidelines. Mats shall be continuous sections running from the levee crest to toe without seams within the TCBM system. The mats shall be 16' wide and run the continuous slope. Each TCBM section shall have an overlapping extension on one long edge. Overlapping extensions consists of an 8" extension of the interlocking bi-axial geogrid. Subsequent mats are installed over the extensions of the previously installed mat.

Secure seams with 250lb stainless steel zip ties in 1' increments, encapsulating 3 cords of grid of either adjacent mat. Provide a minimum 24 in. deep mat embedment toe trench at all edges exposed to concentrated flows.

The manufacturer or authorized representative will provide technical assistance during the slope preparation and installation of the concrete block mats as needed.

7.6 Measurement

This Item will be measured by the square footage used, complete in place.

7.7 Payment

The work performed, and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for Tied Concrete Block Mats. This price is full compensation for loading and transporting, placing concrete block mats; excavation and disposal; furnishing topsoil and bedding; and equipment, labor, materials, tools, and incidentals.

8 GABIONS

8.1 Part 1 General

8.1.1 Summary

The work under this specification includes furnishing, assembling, filling and tying double twist woven wire mesh green gabions placed on a prepared surface as specified, and in accordance with the lines, grades, and dimensions shown on plans or otherwise established in the field by project engineer.

8.1.2 Unit Prices

8.1.2.1 Measurement

Green gabions meeting the requirements of these specifications and acceptably placed within the limits indicated on the drawings or otherwise established in the field, shall be measured for payment by the cubic yard (cubic meter) of stone filled green gabions in place.

8.1.2.2 Payment

Payment shall be made for costs associated with green gabion, including the costs of furnishing, assembling, and placing the wire baskets, the stone fill, and all other materials, labor, equipment, tools, supplies, and incidental costs in connection with completing this item of work.

8.1.3 References

ASTM A90/A90M	Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
ASTM A370	Test Methods and Definitions for Mechanical Testing of Steel Products
A428/A428M	Test Method for Weight [Mass] of Coating on Aluminum-Coated Iron or Steel Articles
ASTM A764	Specification for Metallic Coated Carbon Steel Wire, Coated at Size and Drawn to Size for Mechanical Springs
ASTM A641/A641M	Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A902	Terminology Relating to Metallic Coated Steel Products
ASTM A975	Standard Specification for Double-Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel Wire with Poly Vinyl Chloride (PVC) Coating)
ASTM B117	Practice for Operating Salt Spray (Fog) Apparatus
ASTM D6711	Standard Practice for Specifying Rock to Fill Gabions, Revet Mattresses, and Gabion Mattresses

AASHTO M288	Standard Specification for Geosynthetic Specification for Highway Applications
EN 10245-1	Steel wire and wire products - Organic coatings on steel wire – Part 1: General Rules
EN 60229:2008	Electric Cables – Tests on Extruded Oversheaths with a Special Protective Function
ISO 4892-3	Plastics – Methods of Exposure to Laboratory Light Sources – Part 3: Fluorescent UV Lamps

8.1.4 Definitions

8.1.4.1 Green gabion

Green gabion is a double twisted wire mesh container with inclined front face, interconnected with other similar units and filled with stone and soil at the project site to form flexible, monolithic structures such as streambank restoration and stabilization, and erosion mitigation applications. It is specifically designed to be used with soil bioengineering techniques such as live staking, brush layering and rooted plants, to create permanent vegetative armored systems.

Definitions of terms specific to this specification and to all materials furnished on the jobsite, except for the rock to fill the baskets and the geotextile, shall refer and be in compliance with ASTM A975.

8.1.5 Fabrication

Green gabions shall be manufactured and shipped with all components mechanically connected at the production facility. The front, base, back and lid of the green gabions shall be woven into a single unit. The ends and diaphragm(s) shall be factory connected to the base. The ends shall be pre-cut to the specified angle (45 or 60 degrees) and factory connected to the base. All perimeter edges of the mesh forming the basket and top, or lid, shall be selvedged with wire having a larger diameter. The front face of the green gabion is lined with an erosion control blanket.

8.1.6 Submittals

Preapproved product under these specifications is PoliMac™ coated gabion manufactured by Maccaferri Inc. info@us.maccaferri.com; Tel: 301-223-6910. Submit the following list of items for Engineer's review and approval prior to material supply.

- i. Manufacturer's product technical specifications, and product installation instructions.
- ii. Wire mesh sample with edge and selvedge wires. Minimum sample size shall be 12 in. by 12 in.
- iii. Written manufacturer's certificate of compliance. Manufacturer's Certificate of Compliance shall be signed by person authorized to bind the manufacturer's certifications and must have Manufacturer's name and product manufacturing location.

Equivalent products or any value engineering proposal using alternate product is acceptable provided the following items in addition to above listed are submitted to the Engineer at least 14 days prior to bid.

- i. Test reports from a third-party test laboratory in USA to verify the product compliance with ASTM A975.
- ii. Mill certifications of the wire used in manufacturing the products.
- iii. Manufacturer's Quality Control Manual.
- iv. List of at least ten government projects where the product has been successfully installed.
- v. Certified document that demonstrates manufacturer has at least 10 years of continuous experience in manufacturing green gabions and has manufactured at least 3.0 million cubic yards of green gabions.
- vi. Shop drawings and design calculations along with test reports, signed and sealed by the Professional Engineer registered in the state of project location.

8.1.7 Quality Assurance

8.1.7.1 Wire and Ring Fastener

The owner or owner's representative reserves the right to test additional samples to verify the submitted test records. For equivalent products, furnish minimum three randomly selected field samples of lacing wire and ring fasteners 60 days prior to start of installation. Samples shall be tested to verify following property requirements in accordance with ASTM A975.

- i. Wire thickness
- ii. Tensile strength
- iii. High Abrasion Resistant (HAR) polymer coating thickness
- iv. Ring fastener individual pull apart strength

8.1.7.2 Installation

The General Contractor shall have personals with at least 3 years of experience installing green gabions and have installed a minimum of 1000CY of green gabions in each of the last three years. In case the General Contractor does not meet the qualifications based on the above requirements, acquire necessary onsite training from manufacturer prior to construction or the services of a qualified green gabion subcontractor must be utilized. A manufacturer's representative shall provide reasonable installation support.

8.1.8 Delivery, Storage, and Handling

Green gabions shall be delivered with all components mechanically connected at the production facility. All green gabions are supplied in the collapsed form, either folded or bundled for shipping. Bundles are banded together at the factory for ease of shipping and handling. Deliver green gabions to the jobsite labeled in bundles. Labels show the dimensions of the green gabions included, the number of pieces and the color code. Lacing wire shall be shipped in coils, fasteners in boxes and preformed stiffeners in bundles.

8.2 Part 2 Products

8.2.1 Materials

8.2.1.1 High Abrasion Resistant (HAR) Polymer Coated Green gabions

Double twisted wire mesh green gabions shall be manufactured with a non-raveling mesh made by twisting continuous pairs of wires through three half turns (commonly called double twisted) to form a hexagonal-shaped opening. Green gabion wire diameters, mesh opening sizes, and tolerances shall comply with the requirements of ASTM A975. Green gabions are classified according to the wire coating, which is applied prior to manufacturing the mesh. HAR polymer coated green gabions are manufactured from a heavily zinc coated soft or medium temper steel and overcoated with high abrasion resistant polymer as per ASTM A975. Wire and wire mesh used for manufacturing green gabions shall meet the following requirements:

8.2.1.1.1 Wire Tensile Strength

The wire used for the manufacturing green gabions and lacing wire, shall have a minimum tensile strength of 60,000 psi (415 MPa) to maximum tensile strength of 80,000 psi (550 MPa), in accordance with ASTM A641/A641M.

8.2.1.1.2 Elongation

The test shall be carried out on a sample at least 12 in. (300 mm) long, and the elongation shall not be less than 12%, in accordance with ASTM A370.

8.2.1.1.3 Metallic (Zinc) Coating

The minimum quantities of zinc shall be according to the ASTM A856/A856M, Class III soft or medium temper coating.

8.2.1.1.4 Adherence of Zinc Coating

The adherence of the zinc coating to the wire shall be such that, when the wire is wrapped six turns around a mandrel having four times the diameter of the wire, it does not flake or crack when rubbing it with the bare fingers, in accordance with ASTM A641/A641M.

8.2.1.1.5 HAR Polymer Coating

HAR polymer coating is an environmentally safe extruded polymer coating specifically developed to provide high resistance to abrasion and mechanical damage to improve its performance in cold and hot temperatures and UV radiation.

The technical characteristics and ageing resistance of the HAR polymer coating comply with ASTM A975.

8.2.1.1.5.1 Color: Gray.

8.2.1.1.5.2 *Resistance to UV radiation:* the tensile strength and elongation at break of the base compound after 2500 hours of exposure to QUV-A (ASTM G154 or ISO 4892-3 mode 1) do not change more than 25% from the initial test results.

8.2.1.1.5.3 Brittleness temperature: the brittleness temperature of HAR polymer coating shall be less than -35°C (-31°F) as determined with ASTM D746.

8.2.1.1.5.4 *Outwearing accelerated ageing test in salt spray:* when the HAR polymer coated wire mesh is subjected to the neutral salt spray test (ASTM B117 or ISO 9227) after 6000 hours of exposure the mesh does not show more than 5% of DBR (Dark Brown Rust).

8.2.1.1.5.5 *Resistance to abrasion:* Abrasion is prominent where there is scuffing, scratching, or wearing action caused by actions such as glaciation, suspended solid transport in rivers, or waves breaking on coastlines. The abrasion resistance of the HAR polymer coating shall comply with ASTM A975. Average number of cycles caused by linear abrading action shall be greater than 300.

8.2.1.1.5.6 *Corrosion Spread:* maximum length of corrosion spread on a HAR polymer coated wire shall be less than a mesh opening after immersion in a 5% solution of HCl as per ASTM A975.

8.2.1.1.6 Standard Wire Diameters

All wire diameters shall comply with ASTM A975 as presented in Table 1.

	Lacing Wire, Cross tie	Mesh Wire	Selvedge Wire
Wire Diameter Int Ø in (mm)	0.087 (2.20)	0.106 (2.70)	0.134 (3.40)
Wire Tolerance (\pm) Ø in (mm)	0.004 (0.10)	0.004 (0.10)	0.004 (0.10)
Min. Zinc. oz/ft ² (g/m ²)	0.70 (214)	0.8 (244)	0.85 (259)
Wire + Polymer Diameter in. (mm)	0.127 (3.20)	0.146 (3.70)	0.174 (4.40)

8.2.1.1.7 Mesh Characteristics and Strength Requirements

The wire mesh characteristics and minimum strength requirements shall be in accordance with ASTM A975 as presented in Table 2. The tolerances on the hexagonal double twisted wire mesh opening, D (see Fig. 1), shall not exceed $\pm 10\%$.

Table 2 Mesh Characteristics and Minimum Strength	
Mesh Type	8x10/ HAR Polymer Coated
Mesh Opening, D	3.25 in. (83 mm)
Mesh Tensile Strength	3425 lb/ft (50.0 kN/m)
Punch Test Resistance	5300 lb (23.6 kN)
Connection Strength	1200 lb/ft (17.5 kN/m)

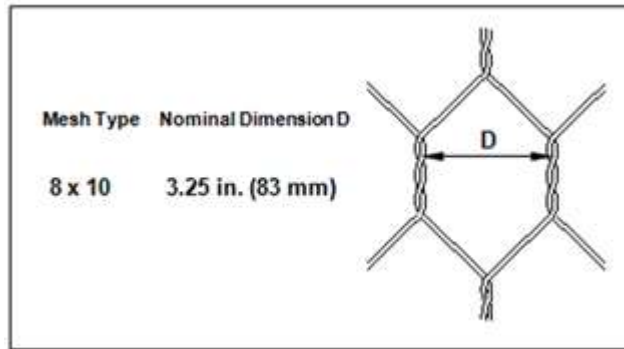


Fig. 1 Mesh type and opening

8.2.1.1.8 Standard green gabion sizes are listed in Table 3. All sizes and dimensions are nominal. The tolerances on width, length and height of baskets shall not exceed $\pm 5\%$.

Table 3 Standard Green Gabion Sizes			
L=Length ft (m)	W=Width ft (m)	H=Height ft (m)	Face Angle
6 (1.83)	3 (0.91)	1.5 (0.45)	45°
6 (1.83)	3 (0.91)	1.5 (0.45)	60°

8.2.1.2 Ring Fasteners

Stainless steel rings for HAR polymer coated green gabions shall be in accordance with ASTM A975 section 6.3. The ring fasteners properties shall be as presented in Table 4.

Table 4 Ring fastener property requirements		
Property	Value	Test Method
Wire diameter	0.120 in. (3.05 mm)	ASTM A313, Type 302, Class I
Wire tensile strength	222,000 to 253,000 psi (1530 to 1744 MPa)	ASTM A313, Table 5

8.2.1.3 Stone Fill

8.2.1.3.1 Properties

Rocks shall be hard, angular to round, durable and of such quality that they shall not disintegrate on exposure to water or weathering during the life of the structure.

8.2.1.3.2 Gradation

The rock used to fill green gabions shall be large enough to prevent individual pieces from passing through the mesh openings. Green gabion rocks shall range between 4 in. and 8 in. (100 mm and 200 mm). The range in sizes shall allow for a variation of 5% oversize and/or 5% undersize rock by weight. In all cases, the sizes of any oversize rock shall allow for the placement of three or more layers of rock within each green gabion compartment. In all cases, undersize rock shall be placed within the interior of the green gabion compartment and shall not be placed on the exposed surface of the structure.

8.2.1.3.3 Source

Rock may be naturally available or crushed rock produced by any suitable method and using any device that yields the required size limits. Alternatively, clean crushed concrete can be used to fill the green gabions.

8.2.1.4 Topsoil

Topsoil shall be sandy clay or clay like sand, with 3% to 20% of organic material. The soil shall be fertile and friable. The topsoil should be free from wood and stones larger than 2 in. (50 mm) in maximum dimension. The vegetative soil is then mixed with the gabion rock (minimum 50 %) and placed in the green gabion baskets.

8.2.1.5 Erosion Control Blanket

Erosion control blanket shall be made with uniformly distributed 100% coconut fiber and two polypropylene net securely sewn together with UV stabilized thread. See technical specification of BIOMAC® CC 028.2 for more information.

8.2.1.6 Geotextile

Separation geotextile, if used behind green gabions, shall meet AASHTO M288 and/or project specification requirements. In most cases, geotextile is not required.

8.3 Part 3 Execution

8.3.1 Foundation Preparation

The foundation for green gabion wall shall be graded level for a width equal as shown in the project plans. Prior to begin the wall construction, the area under the wall footprint should be prepared

and compacted. Any soft or loose material that is encountered should be compacted or removed and replaced. Any debris that will obstruct the proper installation shall also be removed, and the voids carefully backfilled and compacted. If frozen ground conditions are encountered, contact project geotechnical engineer for further recommendations.

8.3.2 Assembly

Green gabions are supplied folded flat and packed in bundles. The units shall be opened and unfolded one by one on a flat, hard surface and remove any shipping folds. This can be done by placing the fold over a 2 in. x 4 in. (50 mm x 100 mm) board and walking along the sides. The front face shall be internally lined using erosion control blanket with an overlap of 12 in (300 mm) at the top and bottom of the unit. The sides and ends shall be lifted into a vertical position to form an open box shape. The back and the front panels of the green gabion shall be connected to the end panels using either lacing wire or ring fasteners. The selvedge wire shall be wrapped around the edge wire of the top and back panels. Fig. 2 shows assembled double twisted wire mesh green gabion.

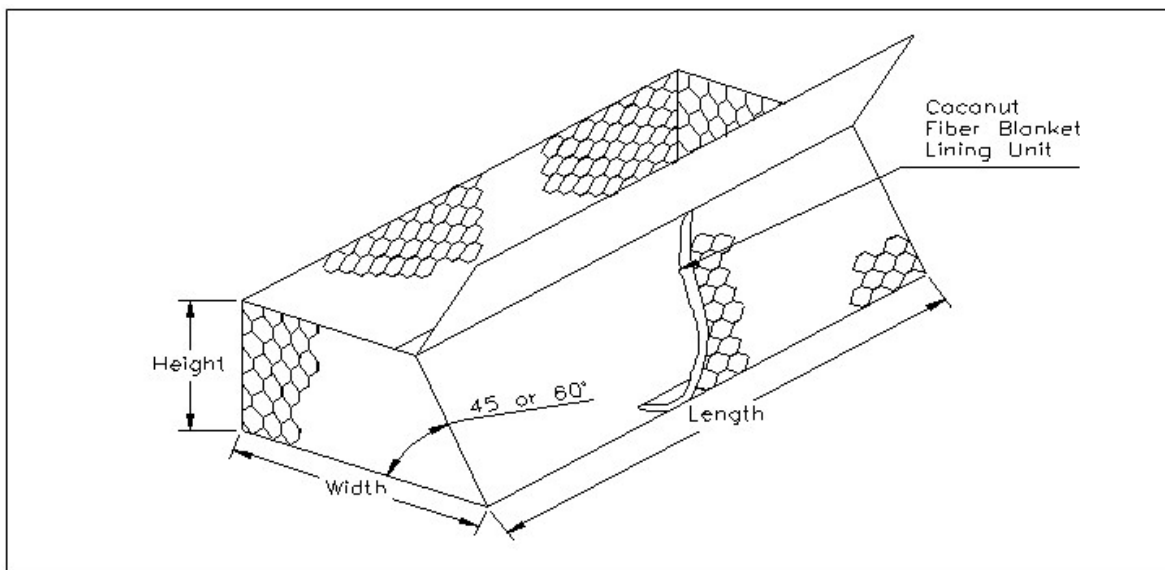


Fig. 2 Unfolded and assembled double twisted wire mesh Green gabion

8.3.3 Fastening Procedures

8.3.3.1 Lacing Wire

When using lacing wire, cut a piece of wire approximately 1.5 times the length of the edge to be laced. Longer edges shall be connected by several lengths of lacing wire. The mesh panels shall be pulled tightly together during the tying operation. For vertical joints, starting at the bottom end of the panel, the lacing wire shall be twisted and wrapped two times around the bottom selvedge and then double and single loops shall be alternated through at intervals not exceeding 6 in. (150

mm) as shown in Fig. 3. The operation shall be finished by looping around the top selvedge wire. The use of pliers to assemble the units with lacing wire is recommended to create tighter joints.

8.3.3.2 Ring Fasteners

When ring fasteners are used to connect green gabion panels, spacing of the rings shall be in accordance with ASTM A975, minimum strength requirements of mesh and connections. In any case, the maximum ring spacing along the edges shall not exceed 4 in. (100 mm) as shown in Fig. 3. Ring fasteners shall be installed at the ends and along the edges. Each ring fastener shall be closed, and the free ends of the fastener shall overlap a minimum of 1 in. (25 mm) as shown in Fig. 3. The use of either a mechanical or a pneumatic fastening tool is required to install ring fasteners.

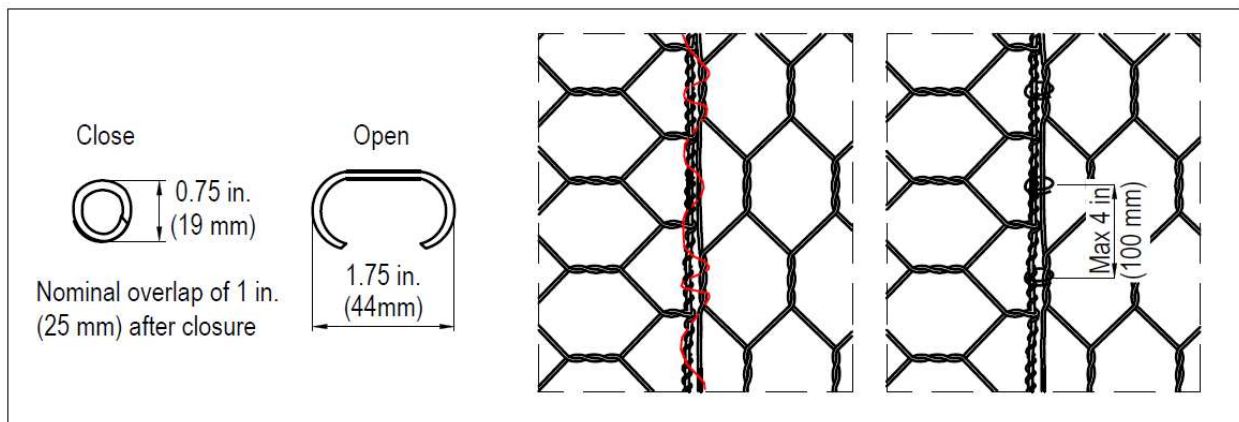


Fig. 3 Fastening procedures

8.3.4 Installation and Filling

Empty green gabion units shall be assembled individually and placed on the approved surface to the lines and grades as shown or as directed by project engineer. Green gabions shall be connected to each other and aligned before filling the baskets with rock. All connections (panel-to-panel) and basket-to-basket shall be already carried out as described in ASSEMBLY section above. Baskets shall be filled with rock (50% minimum) and soil. Green gabions shall be uniformly overfilled by about 1 to 1.5 in. (25 to 40 mm) to compensate for future rock movement. When more than one layer of green gabions is required to form a monolithic structure, the next layer of green gabions shall be connected to the layer underneath after this layer has been securely closed.

8.3.5 Closing

Lids shall be tightly secured along all edges, ends and diaphragms in the same manner as described for assembling. The panel edges shall be pulled and connected with the lid using the appropriate closing tools such as lid closer, where necessary. Adjacent lids shall be securely attached simultaneously, and all end wires shall then be turned in to avoid protrusions.

8.3.6 Non-Rectangular Shapes and Special Adaptations

Where a complete green gabion cannot be installed because of space limitations, the green gabion shall be cut, folded or overlapped, and securely connected to suit existing site conditions. All modified green gabions shall form a closed cell when completed. Green gabion units can conform to bends up to a radius of curvature of 60 to 70 ft (18 to 21 m) without alterations. Units shall be securely connected to each other first, and be placed to the required curvature, holding them in position by staking the units to the ground with hardwood pegs before filling.

8.3.7 Maintenance

No routine maintenance is required. Severely damaged green gabions shall be completely removed and replaced. If the damage is localized in the fascia, the green gabions can be repaired by filling the voids (if any) with rock, and patching it using a new piece of double twisted wire mesh. New piece of wire mesh shall be connected to undamaged mesh with a minimum overlap of 9 to 12 in. (225 to 300 mm) using lacing wire or fasteners.

9 RENO MATTRESSES

9.1 Part 1 General

9.1.1 Summary

The work under this specification includes furnishing, assembling, filling, and tying double twist woven wire mesh Reno Mattress Plus placed on a prepared surface as specified, and in accordance with the lines, grades, and dimensions shown on plans or otherwise established in the field by project engineer.

9.1.2 Unit Prices

9.1.2.1 Measurement

Reno Mattress Plus meeting the requirements of these specifications and acceptably placed within the limits indicated on the drawings or otherwise established in the field, shall be measured for payment by the cubic yard (cubic meter) of stone filled Reno Mattress Plus in place.

9.1.2.2 Payment

Payment shall be made for costs associated with Reno Mattress Plus, including the costs of furnishing, assembling, and placing the wire baskets, the stone fill, and all other materials, labor, equipment, tools, supplies, and incidental costs in connection with completing this item of work.

9.1.3 References

ASTM A90/A90M	Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
ASTM A370	Test Methods and Definitions for Mechanical Testing of Steel Products
A428/A428M	Test Method for Weight [Mass] of Coating on Aluminum-Coated Iron or Steel Articles
ASTM A764	Specification for Metallic Coated Carbon Steel Wire, Coated at Size and Drawn to Size for Mechanical Springs
ASTM A641/A641M	Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A902	Terminology Relating to Metallic Coated Steel Products
ASTM A975	Standard Specification for Double-Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel Wire with Poly Vinyl Chloride (PVC) Coating)
ASTM B117	Practice for Operating Salt Spray (Fog) Apparatus
ASTM D6711	Standard Practice for Specifying Rock to Fill Gabions, Revet Mattresses, and Gabion Mattresses

AASHTO M288	Standard Specification for Geosynthetic Specification for Highway Applications
EN 10245-1	Steel wire and wire products - Organic coatings on steel wire – Part 1: General Rules
EN 60229:2008	Electric Cables – Tests on Extruded Oversheaths with a Special Protective Function
ISO 4892-3	Plastics – Methods of Exposure to Laboratory Light Sources – Part 3: Fluorescent UV Lamps

9.1.4 Definitions

9.1.4.1 Reno Mattress Plus

Reno Mattress Plus is a double-twisted wire mesh container uniformly partitioned into internal cells with relatively small height in relation to other dimensions, having smaller mesh openings than the mesh used for gabions; interconnected with other similar units and filled with stone at the project site to form flexible, permeable, monolithic channel linings, revetments, scour protections and other erosion control structures.

Definitions of terms specific to this specification and to all materials furnished on the jobsite, except for the rock to fill the baskets and the geotextile, shall refer and be in compliance with ASTM A975.

9.1.5 Fabrication

Reno Mattress Plus shall be manufactured from double twisted hexagonal woven steel wire mesh type 6x8, made of PoliMac™ coated steel wire. The base, diaphragms, front, end and sides of the unit are manufactured from one continuous panel of mesh. The diaphragms are created by inserting an upright double-mesh fold in the base panel and secured with spirals at the production facility, which improves the diaphragm stability during filling operations and the hydraulic performance. The Reno Mattress Plus is divided into cells by means of diaphragms positioned at approximately 3 ft (0.9 m) centers. All perimeter edges of the mesh forming the basket and lid, shall be selvedged with wire having a larger diameter (Table 1). To ensure a tighter packing of the filling stones and further improve the hydraulic performances of the mattresses, the units are supplied with pre-formed X-Ties to connect the base panel of the mattress to the lid during the installation.

9.1.6 Submittals

Preapproved product under these specifications is PoliMac™ coated Reno Mattress Plus manufactured by Maccaferri Inc. info@us.maccaferri.com; Tel: 301-223-6910.

Submit the following list of items for Engineer's review and approval prior to material supply.

- i. Manufacturer's product technical specifications, and product installation instructions.
- ii. Wire mesh sample with edge and selvedge wires. Minimum sample size shall be 12 in. by 12 in.

- iii. Written manufacturer's certificate of compliance. Manufacturer's Certificate of Compliance shall be signed by person authorized to bind the manufacturer's certifications and must have Manufacturer's name and product manufacturing location.

Equivalent products or any value engineering proposal using alternate product is acceptable provided the following items in addition to above listed are submitted to the Engineer at least 14 days prior to bid.

- i. Test reports from a third-party test laboratory in USA to verify the product compliance with ASTM A975.
- ii. Mill certifications of the wire used in manufacturing the products.
- iii. Manufacturer's Quality Control Manual.
- iv. List of at least ten government projects where the product has been successfully installed.
- v. Certified document that demonstrates manufacturer has at least 10 years of continuous experience in manufacturing green gabions and has manufactured at least 3.0 million cubic yards of green gabions.
- vi. Shop drawings and design calculations along with test reports, signed and sealed by the Professional Engineer registered in the state of project location.

9.1.7 Quality Assurance

9.1.7.1 Wire and Ring Fastener

The owner or owner's representative reserves the right to test additional samples to verify the submitted test records. For equivalent products, furnish minimum three randomly selected field samples of lacing wire and ring fasteners 60 days prior to start of installation. Samples shall be tested to verify following property requirements in accordance with ASTM A975.

- i. Wire thickness
- ii. Tensile strength
- iii. High Abrasion Resistant (HAR) polymer coating thickness
- iv. Ring fastener individual pull apart strength

9.1.7.2 Installation

The General Contractor shall have personals with at least 3 years of experience installing mattresses and have installed a minimum of 500 SY of mattresses in each of the last three years. In case the General Contractor does not meet the qualifications based on the above requirements, acquire necessary onsite training from manufacturer prior to construction or the services of a qualified mattresses subcontractor shall be utilized. A manufacturer's representative shall provide reasonable installation support.

9.1.8 Delivery, Storage, and Handling

Reno Mattress Plus shall be delivered with all components mechanically connected at the production facility except the lid and X-Ties which are delivered separately from the base. All

Reno Mattresses Plus are supplied in the collapsed form, either folded, bundled or rolled for shipping. Bundles and rolls are banded together at the factory for ease of shipping and handling. Deliver Reno Mattresses Plus to the jobsite labeled in bundles. Labels show the dimensions of the Reno Mattresses Plus included, the number of pieces and the color code. Lacing wire shall be shipped in coils, fasteners in boxes and X-Ties in bundles.

9.1.9 Permissible Shear Stress

The values of the permissible shear stress in unvegetated condition shall be as presented in Table 1. The values of the permissible shear stress shall be provided by the manufacturer and shall be supported by full scale tests carried out at third-party accredited laboratory following the ASTM D6460 test methodology.

Table 1 Permissible shear stress		
Reno Mattress Plus thickness, in. (mm)	Permissible shear stress psf (N/m ²)*	Test method
6 (150)	9.30 (445)	ASTM D6460
9 (230)	11.15 (534)	
12 (300)	13.30 (637)	

(*) Flume test values - Design values depend on installation procedures (use of X-Ties) and actual stones characteristics (D_{50} , C_u)

9.2 **Part 2 Products**

9.2.1 Materials

9.2.1.1 High Abrasion Resistant (HAR) Polymer Coated Reno Mattress Plus

Double twisted wire mesh Reno Mattresses Plus shall be manufactured with a non-raveling mesh made by twisting continuous pairs of wires through three half turns (commonly called double twisted) to form a hexagonal-shaped opening. Reno Mattress Plus sizes, wire diameters, mesh opening size, and tolerances shall comply with the requirements of ASTM A975. Reno Mattresses Plus are classified according to the wire coating, which is applied prior to manufacturing the mesh. HAR polymer coated Reno Mattresses Plus are manufactured from a heavily zinc coated soft or medium temper steel and overcoated with high abrasion resistant polymer as per ASTM A975. Wire and wire mesh used for manufacturing Reno Mattresses Plus shall meet the following requirements.

9.2.1.1.1 Wire Tensile Strength

The wire used for the manufacturing Reno Mattresses Plus and lacing wire, shall have a minimum tensile strength of 60,000 psi (415 MPa) to maximum tensile strength of 80,000 psi (550 MPa), in accordance with ASTM A641/A641M.

9.2.1.1.2 Elongation

The test shall be carried out on a sample at least 12 in. (300 mm) long, and the elongation shall not be less than 12%, in accordance with ASTM A370.

9.2.1.1.3 Metallic (Zinc) Coating

The minimum quantities of zinc shall be according to the ASTM A856/A856M, Class III soft or medium temper coating.

9.2.1.1.4 Adherence of Zinc Coating

The adherence of the zinc coating to the wire shall be such that, when the wire is wrapped six turns around a mandrel having four times the diameter of the wire, it does not flake or crack when rubbing it with the bare fingers, in accordance with ASTM A641/A641M.

9.2.1.1.5 HAR Polymer Coating

HAR polymer coating is an environmentally safe extruded polymer coating specifically developed to provide high resistance to abrasion and mechanical damage to improve its performance in cold and hot temperatures and UV radiation.

The technical characteristics and ageing resistance of the HAR polymer coating comply with ASTM A975.

9.2.1.1.5.1 Color: Gray.

9.2.1.1.5.2 *Resistance to UV radiation:* the tensile strength and elongation at break of the base compound after 2500 hours of exposure to QUV-A (ASTM G154 or ISO 4892-3 mode 1) do not change more than 25% from the initial test results.

9.2.1.1.5.3 *Brittleness temperature:* the brittleness temperature of HAR polymer coating shall be less than -35°C (-31°F) as determined with ASTM D746.

9.2.1.1.5.4 *Outwearing accelerated ageing test in salt spray:* when the HAR polymer coated wire mesh is subjected to the neutral salt spray test (ASTM B117 or ISO 9227) after 6000 hours of exposure the mesh does not show more than 5% of DBR (Dark Brown Rust).

9.2.1.1.5.5 *Resistance to abrasion:* Abrasion is prominent where there is scuffing, scratching, or wearing action caused by actions such as glaciation, suspended solid transport in rivers, or waves breaking on coastlines. The abrasion resistance of the HAR polymer coating shall comply with ASTM A975. Average number of cycles caused by linear abrading action shall be greater than 300.

9.2.1.1.5.6 *Corrosion Spread:* maximum length of corrosion spread on a HAR polymer coated wire shall be less than a mesh opening after immersion in a 5% solution of HCl as per ASTM A975.

9.2.1.1.6 Standard Wire Diameters

All wire diameters shall comply with ASTM A975 as presented in Table 1.

Table 2 Standard Wire Diameters			
	Lacing Wire, Cross tie	Mesh Wire	Selvedge Wire
Wire Diameter Int Ø in (mm)	0.087 (2.20)	0.087 (2.20)	0.106 (2.70)
Wire Tolerance (\pm) Ø in (mm)	0.004 (0.10)	0.004 (0.10)	0.004 (0.10)
Min. Zinc. oz/ft ² (g/m ²)	0.70 (214)	0.7 (214)	0.80 (244)
Wire + Polymer Diameter in. (mm)	0.127 (3.20)	0.127 (3.20)	0.146 (3.70)

9.2.1.1.7 Mesh Characteristics and Strength Requirements

The wire mesh characteristics and minimum strength requirements shall be in accordance with ASTM A975 as presented in Table 2. The tolerances on the hexagonal double twisted wire mesh opening, D (see Fig. 1), shall not exceed $\pm 10\%$.

Table 3 Mesh Characteristics and Minimum Strength	
Mesh Type	6x8/ HAR Polymer
Mesh Opening, D	2.5 in. (64 mm)
Mesh Tensile Strength	2300 lb/ft (33.6 kN/m)
Punch Test Resistance	4000 lb (17.8 kN)
Connection Strength	700 lb/ft (10.2 kN/m)

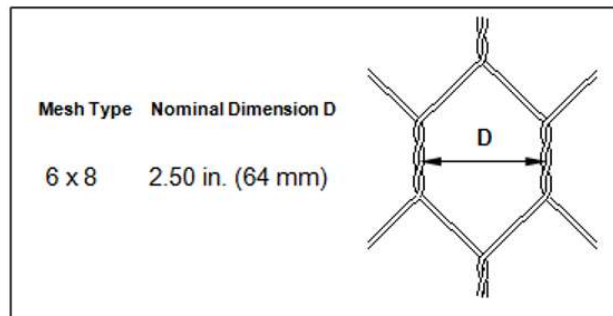


Fig. 1 Mesh type and opening

9.2.1.1.8 Standard Reno Mattress Plus sizes are listed in Table 4. All sizes and dimensions are nominal. The tolerances on width, length and height of baskets shall not exceed $\pm 5\%$.

L=Length ft (m)	W=Width ft (m)	H=Height in (mm)	# of cells
9 (2.74)	6 (1.83) / 9 (2.74)	6 (150)	3
12 (3.66)	6 (1.83) / 9 (2.74)	6 (150)	4
9 (2.74)	6 (1.83) / 9 (2.74)	9 (230)	3
12 (3.66)	6 (1.83) / 9 (2.74)	9 (230)	4
9 (2.74)	6 (1.83) / 9 (2.74)	12 (300)	3
12 (3.66)	6 (1.83) / 9 (2.74)	12 (300)	4

9.2.1.2 Ring Fasteners

Stainless steel rings for HAR polymer coated green gabions shall be in accordance with ASTM A975 section 6.3. The ring fasteners properties shall be as presented in Table 4.

Property	Value	Test Method
Wire diameter	0.120 in. (3.05 mm)	ASTM A313, Type 302, Class I
Wire tensile strength	222,000 to 253,000 psi (1530 to 1744 MPa)	ASTM A313, Table 5

9.2.1.3 X-Tie

X-Tie is a pre-formed bracing system made of galvanized steel wire used to secure a tighter packing of the filling stones and improve the hydraulic performances of Reno Mattress Plus unit, enabling a quick and easy connection of the base panel to the lid during the installation process on the site. The X-Tie properties shall be as presented in Table 6.

Property	Value	Test Method
Wire diameter (int./ext.)	0.153 in. (3.9mm)	ASTM A641/A641M
Wire tensile strength	60,000 psi (413MPa) to 70,000 psi (485 MPa)	ASTM A641/A641M

9.2.1.4 Stone Fill

9.2.1.4.1 Properties

Rocks shall be hard, angular to round, durable and of such quality that they shall not disintegrate on exposure to water or weathering during the life of the structure.

9.2.1.4.2 Gradation

The rock used to fill Reno Mattresses Plus shall be large enough to prevent individual pieces from passing through the mesh openings. The recommended rock sizes for Reno Mattress Plus are given in Table 7, as per ASTM D6711.

Table 7 Recommended Rock Sizes	
Reno Mattress Plus thickness, in. (mm)	Rock size, in. (mm)
6 (150)	3 – 5 (80 - 130)
9 (230)	3 – 5 (80 - 130)
12 (300)	4 – 8 (100 – 200)

The range in sizes shall allow for a variation of 5% oversize and/or 5% undersize rock by weight. In all cases, the sizes of any oversize rock shall allow for the placement of three or more layers of rock within each Reno Mattress Plus compartment. In all cases, undersize rock shall be placed within the interior of the Reno Mattress Plus compartment and shall not be placed on the exposed surface of the structure.

9.2.1.4.3 Source

Rock may be naturally available or crushed rock produced by any suitable method and using any device that yields the required size limits. Alternatively, clean crushed concrete can be used to fill the Reno Mattresses Plus.

9.2.1.5 Geotextile

Separation geotextile used underneath Reno Mattresses Plus shall meet AASHTO M288 and/or project specification requirements.

9.3 Part 3 Execution

9.3.1 Foundation Preparation

The foundation for Reno Mattresses Plus shall be graded level for a width equal as shown in the project plans. Prior to begin the mattress installation, the area under the mattress footprint should be prepared and compacted. Any soft or loose material that is encountered should be compacted or removed and replaced. Any debris that will obstruct the proper installation shall also be removed, and the voids carefully backfilled and compacted.

9.3.2 Geotextile Placement

Geotextile shall be placed uniformly on the surface as indicated on the drawings or as directed by the project engineer. Place the geotextile in close contact with the soil, eliminating folds or excessive wrinkles both longitudinally and transversely. The geotextile shall be installed with

adequate overlap. The minimum overlap distance in the transverse or longitudinal direction is 2.0 ft (0.6 m), except in underwater installations where the minimum overlap is 3.0 ft (1.0 m). It is recommended that traffic not run on exposed geotextile.

9.3.3 Assembly

Reno Mattresses Plus are supplied folded flat and packed in bundles. The units shall be opened and unfolded one by one on a flat, hard surface and remove any shipping folds. This can be done by placing the fold over a 2 in. x 4 in. (50 mm x 100 mm) board and walking along the sides. The sides, ends, and diaphragms shall be lifted into a vertical position to form an open box shape. The back and the front panels of the Reno Mattress Plus shall be connected to the end panels and center diaphragms using either lacing wire or ring fasteners. The end panels and the diaphragms shall be raised to a vertical position and the selvedge wire shall be wrapped around the edge wire of the top and back panels. Fig. 2 shows assembled double twisted wire mesh Reno Mattress Plus.

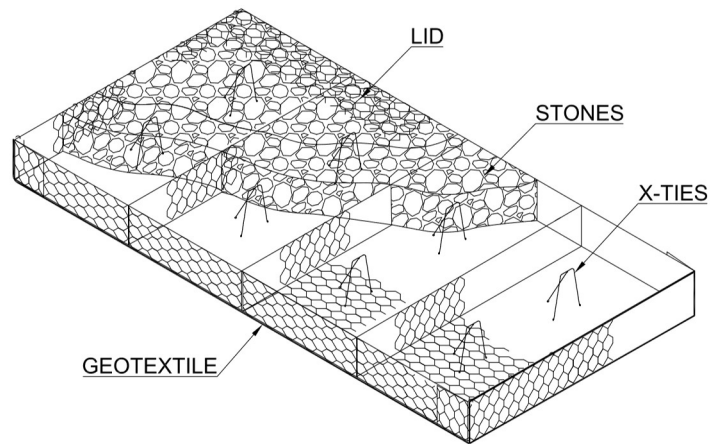


Fig. 2 Assembled double twisted wire mesh Reno Mattress Plus

9.3.4 Fastening Procedures

9.3.4.1 Lacing Wire

When using lacing wire, cut a piece of wire approximately 1.5 times the length of the edge to be laced. Longer edges shall be connected by several lengths of lacing wire. The mesh panels shall be pulled tightly together during the tying operation. For vertical joints, starting at the bottom end of the panel, the lacing wire shall be twisted and wrapped two times around the bottom selvedge and then double and single loops shall be alternated through at intervals not exceeding 6 in. (150 mm) as shown in Fig. 3. The operation shall be finished by looping around the top selvedge wire. The use of pliers to assemble the units with lacing wire is recommended to create tighter joints.

9.3.4.2 Ring Fasteners

When ring fasteners are used to connect Reno Mattress Plus panels, spacing of the rings shall be in accordance with ASTM A975, minimum strength requirements of mesh and connections. In any case, the maximum ring spacing along the edges shall not exceed 6 in. (150 mm) as shown in Fig.

3. Ring fasteners shall be installed at the end, diaphragms and along the edges. Each ring fastener shall be closed, and the free ends of the fastener shall overlap a minimum of 1 in. (25 mm) as shown in Fig 3. The use of either a mechanical or a pneumatic fastening tool is required to install ring fasteners.

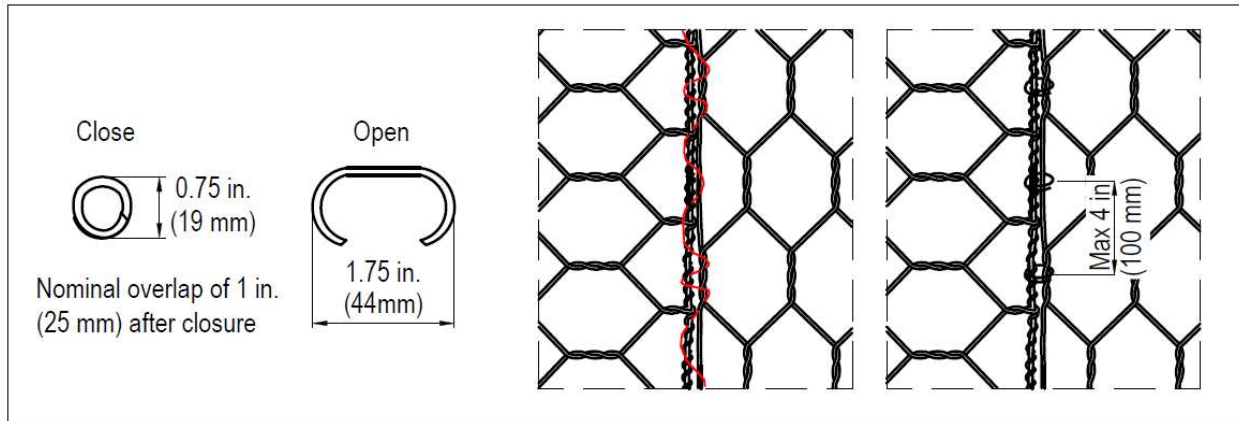


Fig. 3 Fastening procedures

9.3.5 X-Ties

To secure a tighter packing of the rock filling and improve the hydraulic performances of the mattresses, pre-shaped X-Ties connecting the base panel to the lid shall be installed on the site (1 X-Tie/SY). X-Tie is a pre-shaped bracing system with the vertical leg connecting the base panel to the lid and the inclined tie to keep the vertical leg into position during the stone filling operations. The upper part of the vertical leg is eventually fixed to the lid by means of 2 ring fasteners.

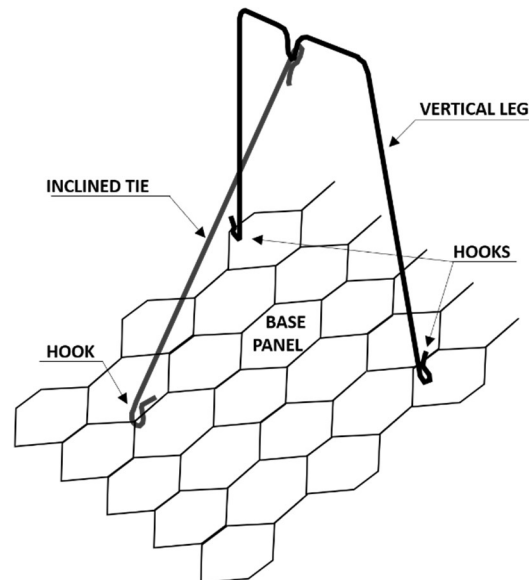


Fig. 4 X-Tie

9.3.6 Installation and Filling

Empty Reno Mattress Plus units shall be assembled individually and placed on the approved surface to the lines and grades as shown or as directed by project engineer. Reno Mattresses Plus shall be aligned and connected to each other before filling with rocks. All connections (panel-to-panel) and basket-to-basket shall be already carried out as described in ASSEMBLY section above. X-Ties shall be attached to the base as described in Section 3.5 prior to rock filling. Mattresses shall be filled with rock sizes as specified in Section 2.1.3.2. During the filling, some manual stone placement is required to minimize voids. Reno Mattresses Plus shall be uniformly overfilled by about 1 to 1.5 in. (25 to 40 mm) to compensate for future rock movement.

9.3.7 Closing

After the Reno Mattresses Plus are filled, lids shall be laid and tightly secured along all edges, ends and diaphragms in the same manner as described for assembling. The panel edges shall be pulled and connected with the lid using the appropriate closing tools such as lid closer, where necessary. Adjacent lids shall be securely attached simultaneously, and all end wires shall then be turned in to avoid protrusions.

9.3.8 Non-Rectangular Shapes and Special Adaptations

Where a complete Reno Mattress Plus cannot be installed because of space limitations, the mattress shall be cut, folded or overlapped, and securely connected to suit existing site conditions. All modified Reno mattresses shall form a closed cell when completed. Reno Mattress Plus units can conform to bends up to a radius of curvature of 60 to 70 ft (18 to 21 m) without alterations. Units shall be securely connected to each other first, and be placed to the required curvature, holding them in position by staking the units to the ground with hardwood pegs before filling.

9.3.9 Maintenance

No routine maintenance is required. Severely damaged Reno Mattresses Plus shall be completely removed and replaced. If the damage is localized, the Reno Mattresses Plus can be repaired by filling the voids (if any) with rock, and patching it using a new piece of double twisted wire mesh. New piece of wire mesh shall be connected to undamaged mesh with a minimum overlap of 9 to 12 in. (225 to 300 mm) using lacing wire or fasteners.